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SCHEDULE 16. DISTRIBUTION STATEMENT (of this Report) Approved for public release: N STATEMENT (of the abstract entered in Block 20 18. SUPPLEMENTARY NOTES 19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Noise Aircraft Noise Environments KC-135A Aircraft Bioenvironmental Noise Suppressors 20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The AF32A-52A noise suppressor was made by Industrial Acoustics Corporation and modified by the Air Force for acoustical suppression of the KC-135A aircraft. This report provides measured and extrapolated data defining the bioacoustic environments produced by this aircraft operating in an AF32A-52A suppressor for three engine power configurations. Far-field data measured at 19 locations are normalized to standard -

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meteorological conditions and extrapolated from 75-8000 meters to derive sets of equal-value contours for seven acoustic measures as functions of angle and distance from the source. Refer to Volume 1 of this handbook, "USAF Bioenvironmental Noise Data Handbook, Vol 1: Organization, Content and Application", AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.



# **PREFACE**

This report was prepared by the Biodynamic Environment Branch, Aerospace Medical Research Laboratory, under Project/Task 723107, Technology to Define and Assess Environmental Quality of Noise From Air Force Operations.

The author gratefully acknowledges Mr. John Cole and Mr. Robert Powell for their assistance in preparing this report, Capt. Nick Farinacci for his assistance in acquiring the raw data, Mr. Keith Kettler, Mr. Henry Mohlman and Mr. Fred Lampley of the University of Dayton for assistance in the mechanics of data processing, and Mrs. Peggy Massie for assistance in typing this report.

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## INTRODUCTION

The KC-135A is an aerial refueling tanker powered by four Pratt and Whitney J57-P-59W engines. The aircraft is manufactured by the Boeing Company and code named the Stratotanker. The AF32A-52A noise suppressor was made by the Industrial Acoustics Corporation for use by Tactical Air Command (TAC) on the J57-P-21 engines, and has been modified according to specifications developed by the US Navy for use with their F-8 aircraft, which use the J57 engines. The modification consists of replacing the original colander with one fabricated of 1/4-inch cold-rolled steel, perforated with 1/4-inch diameter holes so as to remove approximately 30% of the colander surface area. The modification drawings are on file at the 126 Aerial Refueling Wing (ANG)/MA, O'Hare International Airport, Chicago IL 60666. This modified AF32A-52A portable type suppressor provides noise level reduction for the KC-135A aircraft during ground runup operations.

This volume provides measured and extrapolated data defining bioacoustic environments produced by this aircraft in this suppressor system during ground runup operations. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with ground runups of the KC-135A aircraft operating in the AF32A-52A noise suppressor.

This volume is one of a series published by the Aerospace Medical Research Laboratory (AMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of air Force aircraft and ground support equipment. The far-field, community-type noise data in the handbook describe the noise produced during ground operations of aircraft, ground support equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. Volume 2 provides a method and data for adjusting the handbook's far-field noise data, which are for standing meteorological conditions (15°C temperature, 70% rel humidity, 0.760 meters Hg barometric pressure), to derive comparable data for other meteorological conditions. Refer to Volumes 1 and 2 (references 1 and 2) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., inflight/flight crew and passenger noise, near-field/ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published. This index is periodically updated as individual volumes are published and is available upon request from AMRL/BBE, Wright-Patterson AFB, OH 45433. Organizations on the distribution list for the handbook will automatically receive a copy of each updated index.

Direct any questions concerning the technical data in this report and other handbook volumes to AMRL/BBE, Wright-Patterson AFB, OH 45433; AUTOVON 78-53675 or 78-53664; Commercial (513) 255-3675 or (513) 255-3664.

Cole, John N., USAF Bioenvironmental Noise Data Handbook Volume 1: Organization, Content and Application, AMRL-TR-74-50 (1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.

Cole, John N., USAF Bioenvironmental Noise Data Handbook, Volume 2: Procedure to Evaluate Effects of Non-standard Meteorological Conditions on Far-Field Noise, AMRL-TR-75-50 (2), AMRL, WPAFB, OH 1975.

## **FAR-FIELD NOISE**

#### **MEASUREMENTS**

AMRL acquired the far-field data during a 1-2-hour test period, thus keeping similar meteorological conditions. Figure 1 shows the aircraft on a concrete parking apron in the suppressor and its orientation relative to 19 microphone measurement sites on a 100 meter (328 feet) semicircle. The center of the semicircle was located on the ground directly beneath the intersection of the aircraft centerline and a plane passing through the exhaust nozzle of the muffler when installed on the inboard engine (#3 engine).

Table 1 provides cockpit readouts of engine characteristics (% RPM, fuel flow, etc.) for each power setting used in the far-field tests. Also listed in this table are the surface meteorological conditions during data acquisition.

All 19 microphone measurement sites are in the acoustic far-field of the source where the sound wave-fronts spherically diverge and the noise source may be regarded as a point source.

A portable microphone/tape-recorder system was used to sequentially record the noise at each far-field location. The microphone was attached to a hand held pole, pointed at the source (0° angle of incidence) and vertically scanned from 0.5 to 3 meters for a period of 5-10 seconds during data acquisition at each microphone location. These samples were then time-integrated to derive a root-mean-square sound pressure level. Vertical scanning and time-integrating together reduce anomalies frequently present in data acquired by a fixed height microphone.

#### RESULTS

Table 2 lists the overall and 1/3 octave band SPL measured at the far-field locations under meteorological conditions at the time of the test. Data in all other figures and tables are based on these levels. These data were normalized to 100 meters distance and standard meteorological conditions (15°C temperature, 70% relative humidity, 0.760 meter Hg barometric pressure) and used to derive the graphic data in Figure 2 which provides a compact summary of the far-field noise characteristics of the KC-135A aircraft operating in the modified AF32A-52A noise suppressor in a standard format.

Figure 3 and Table 3 present two basic acoustic measures, the acoustic power level and the directivity index, respectively. The acoustic power level describes the power radiated by the source as a function of frequency. The directivity index is a standard acoustical engineering measure that describes the geometric way in which the source radiates this power as a function of both frequency and angle from source. These basic source measures are primarily of interest for acoustical engineers and noise generation/control specialists.

Estimates of the noise levels for intermediate power settings (e.g., 90% RPM) and/or different number of engines operating (e.g., single engine) can be determined as explained in Volume 1 of this handbook.

Figures 4 through 10 are sets of equal noise contours describing seven different measures of noise as a function of angle and distance from the source for standard day meteorology. They are respectively, overall sound pressure level, C-weighted sound level, A-weighted sound level, perceived noise level, speech interference level, permissible exposure times for personnel and octave band sound pressure levels.

Data excessively influenced by spurious background/electronic noise were eliminated from all figures and tables.

Test personnel performed noise surveys during quiet periods when the background noise was minimal. e.g., early in the morning when no other aircraft or engine test stands were operating. Data eliminated because they were near the background/electronic noise were generally not significant because the levels were so low.

Volume 2 of the handbook describes the influence of meteorology on far-field noise environments, and provides, if required, the factors necessary to adjust the handbook's standard meteorological day data.

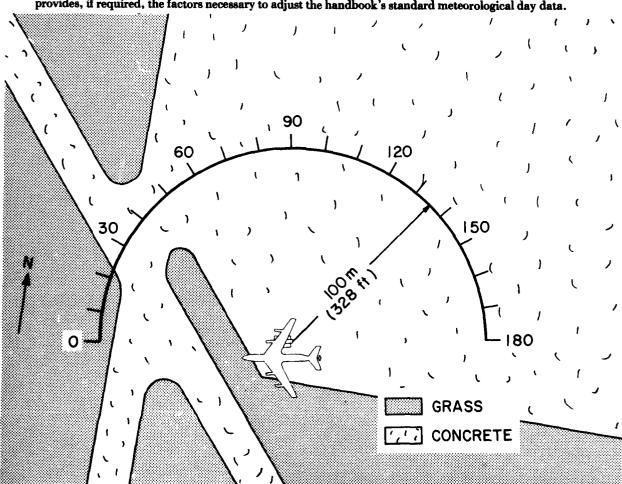


Figure 1. Far-Field Measurement Locations on Parking Apron, O-Hare Int. Airport, Chicago IL

# TABLE 1

# TEST CONDITIONS FOR FAR-FIELD NOISE MEASUREMENTS

C-135A Aircraft In The Modified AF32A-52A Noise Suppressor, Ground Runup O'Hare Int. Arpt., Chicago IL, Test #77-726-001

# Aircraft Engine Operation

1

80% RPM One Engine 80 % RPM

315 °C EGT 1.22 E.P.R.

2200 LBS/HR Fuel Flow

Military Power (Dry) One Engine

95.5 % RPM 607 °C EGT 2.35 E.P.R.

8550 LBS/HR Fuel Flow

Military Power (Wet)

One Engine 96.3 % RPM 615 °C EGT 2.79 E.P.R.

13,000 LBS/HR Fuel Flow

## Meteorology

Wind — Speed 3.5 M/Sec (7 Kt)

- Direction 250 Deg

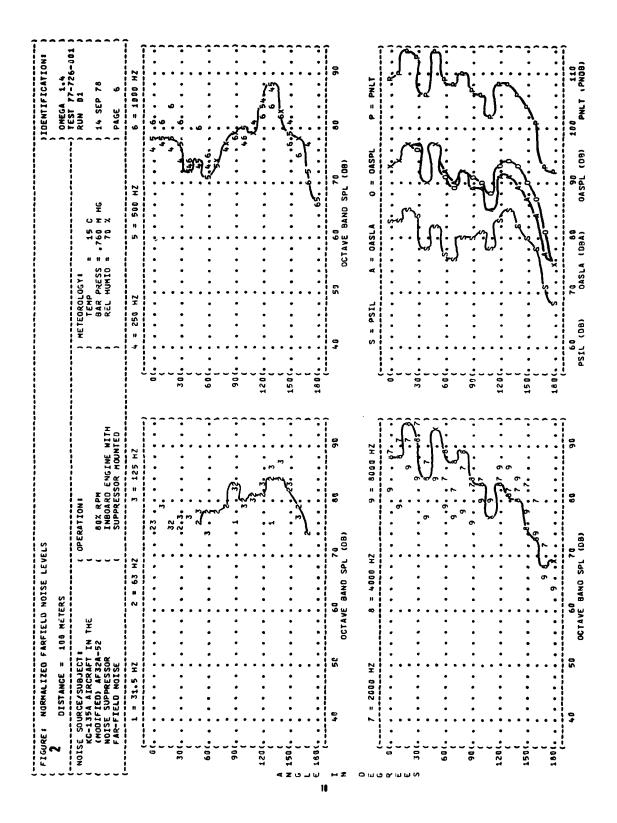
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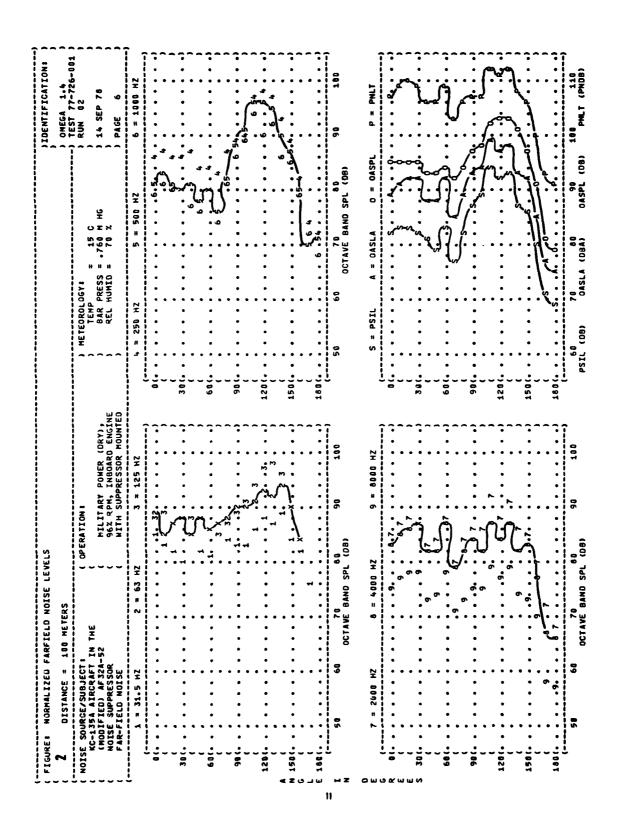
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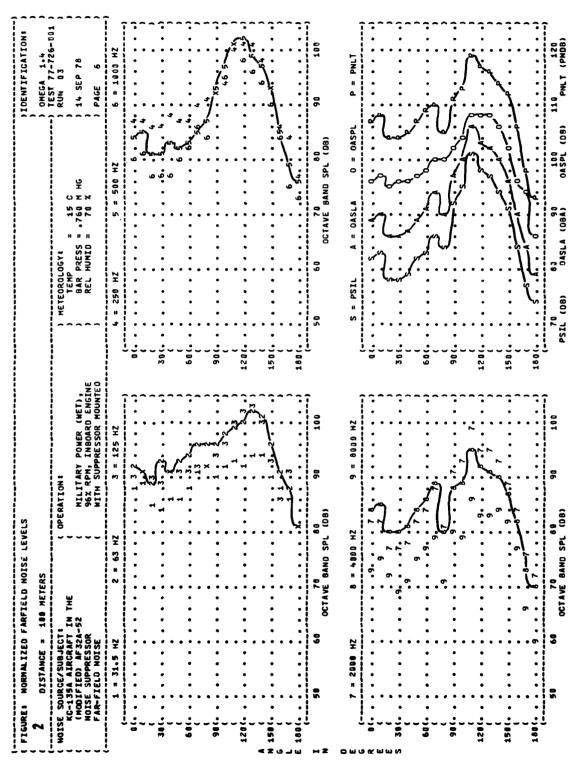
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C OVERALL	٦ 96	96	46	96	96	26	96	1 001	100 1	101	104 1	108 1	108	108	106	101	95	<b>†</b> 6	86

< LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.</pre>







MOISE SOURCE/SUBJECT: (MODIFIED) AF32A-52 MOISE SUPPRESSOR FAR-FIELD NOISE  25 ( 31.5 ( 31.5 ( 10.0 ( 125 ( 125 ( 10.0 ( 125 ( 10.0 ( 125 ( 125 ( 125 ( 10.0 ( 125	O CT AVE	ERATION: 80% RPH INBOARD ENGINE MITH SUPPRESSOR MOUNTED		TEST (	77-726-001
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	•			) 123.2	128.7
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	•	יי נטיי	•	124.0	•
1256 C	•			122.9	160.1
1600	. •		· / /	127.6	
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	•			126.3	
	•			136.4	137.7
	•	•	34 / / .	129.5	
6300 (	•	•		132.8	;
10000	•		3	125.8	134.6
) PIEGANO	•				4.62. A
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		11111111111111111111111111111111111111		(	

ISE SOURCE/SUBJECT: ( OPERATION: KC-135A ATCRAFT IN THE ( MILITARY POWER ( 96% RPM, INBOAR: NOISE SUPPRESSOR ( 96% RPM, INBOAR: RAR-FIELD NOISE ( MITH SUPPRESSOR ( 25 (	. ~ _	) METEOROLOGY:		•
-52 ( MILITARY 96% RPW, ( WITH SUPP 3 = 1/3 OCTAVE	~ 0			) TEST //-/26-001 ) RUN 02 )
= 1/3 OCTAVE	3	BAR PRESS	242 =	14 SEP 78
3 # 1/3	SSOR MOUNTED	י אניר אטא	26	PAGE 3
	1 = OCTAVE		OVERALL	PHL
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NOISE SOURCE/SUBJECT: KG-135A AIRCRAFT IN (MODIFIED) AF32A-52 NOISE SUPPRESSOR FAR-FIELD NOISE										OMEGA	406
(MODIFIED) NOISE SUPP FAR-FIELD		CT 1	3d6 -	OPERATION:			METEOROLOGY: TEMP	,	2	RUN (	,,-,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
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	NOISE				SUPPRESSOR HOUNTED					PAGE	m
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+			• •	• •	•	}-M	_		• •	139.8	
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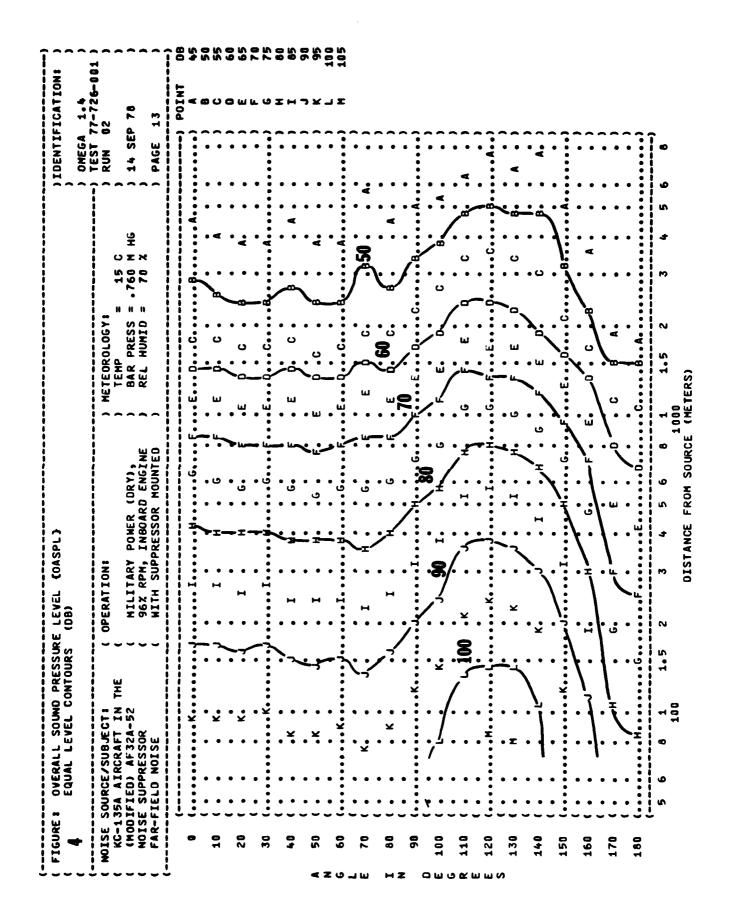
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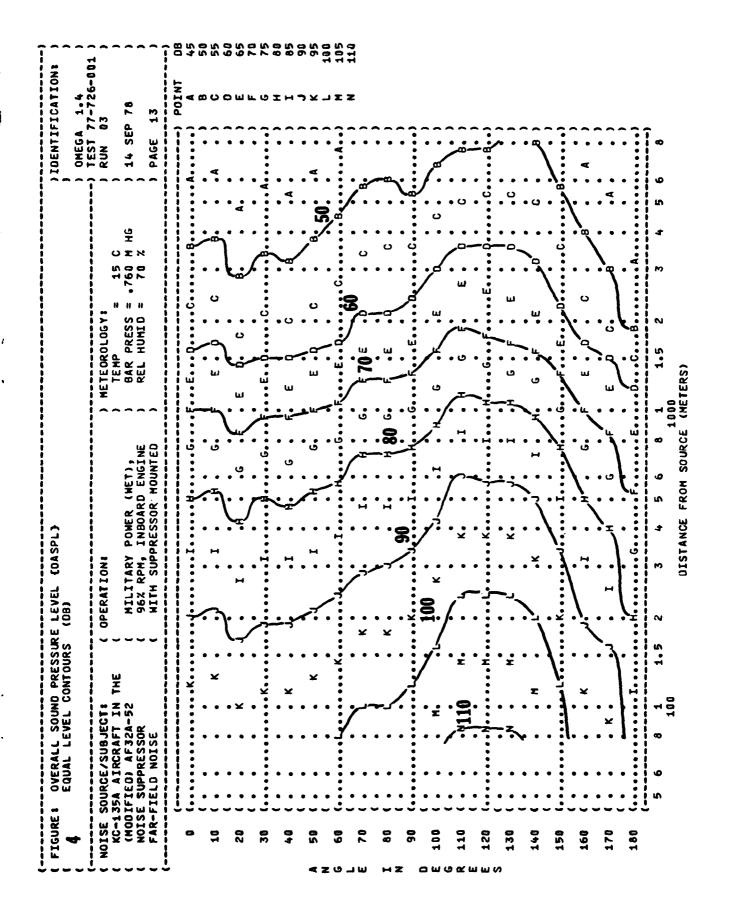
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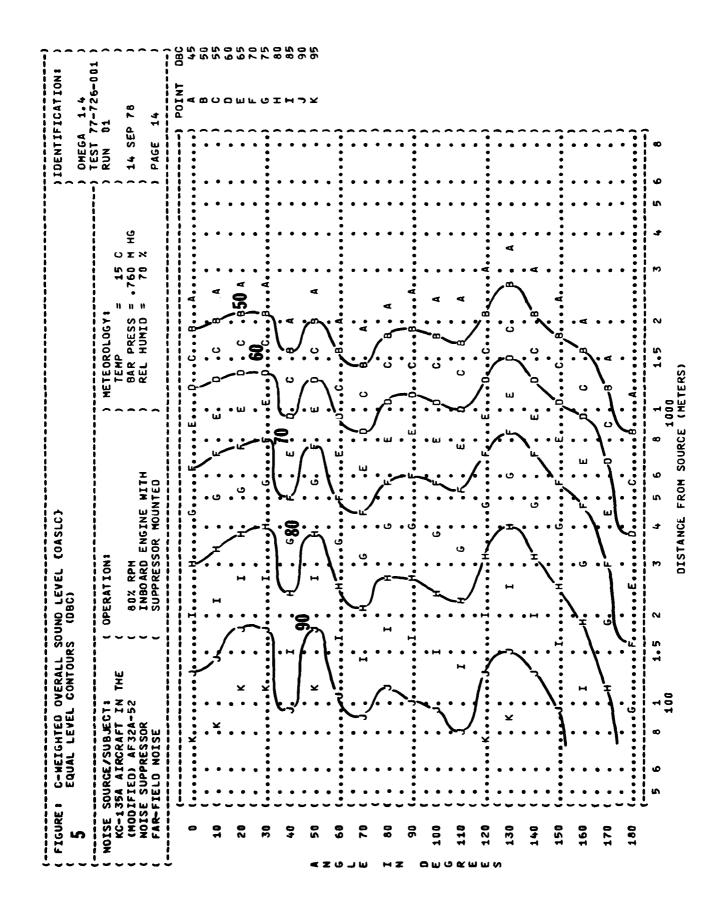
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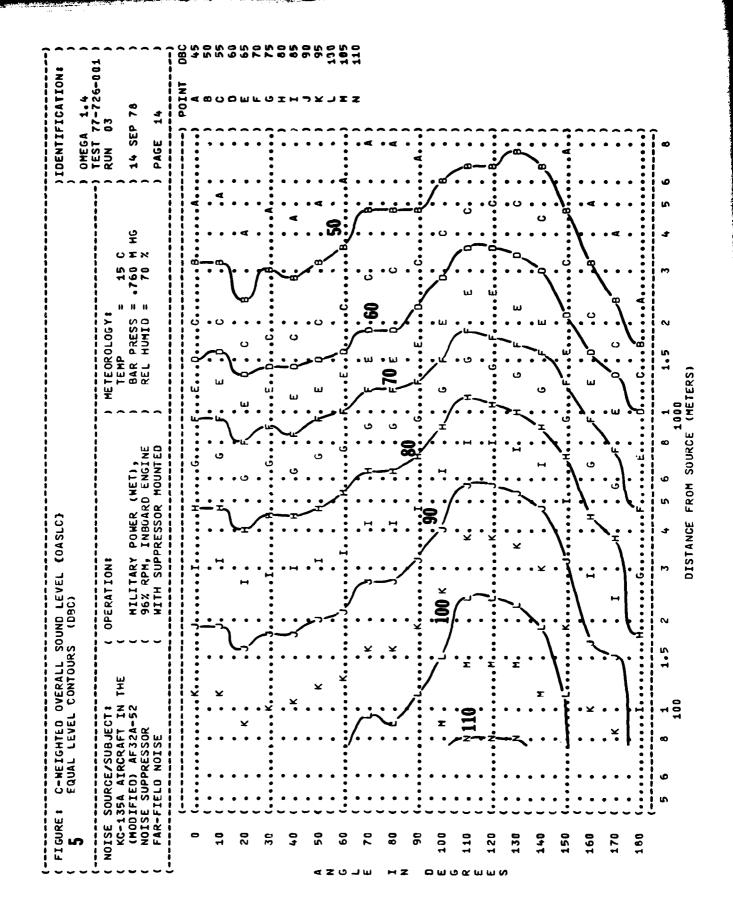
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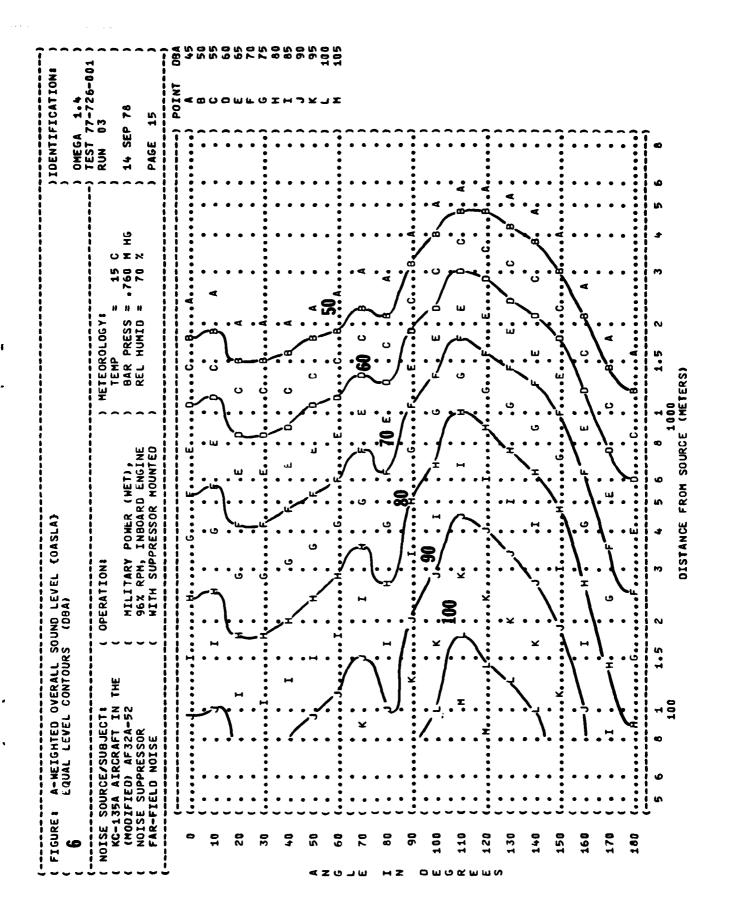


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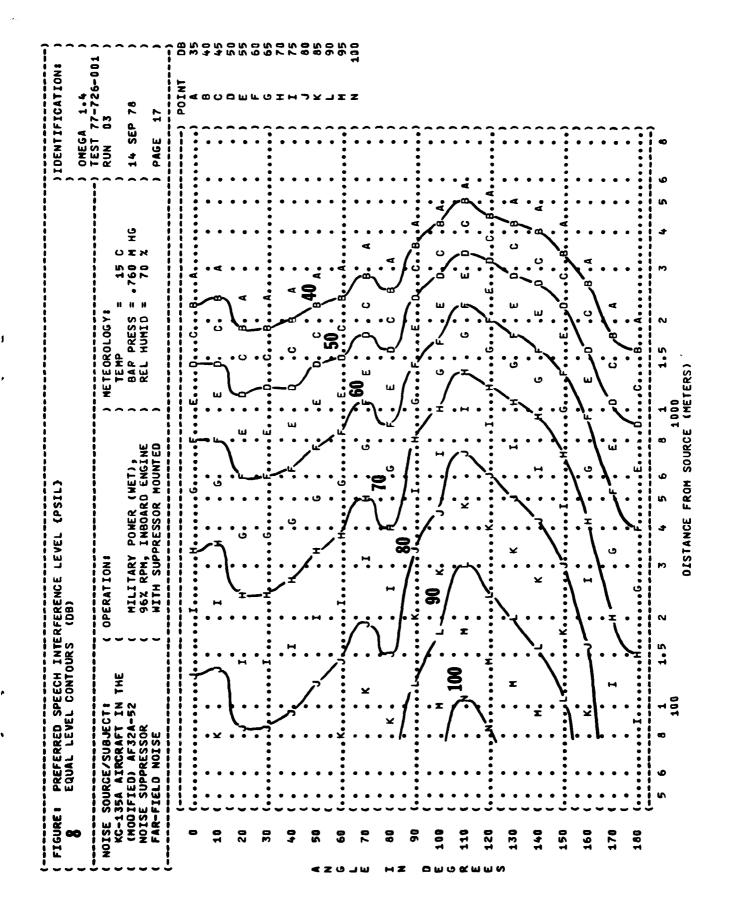
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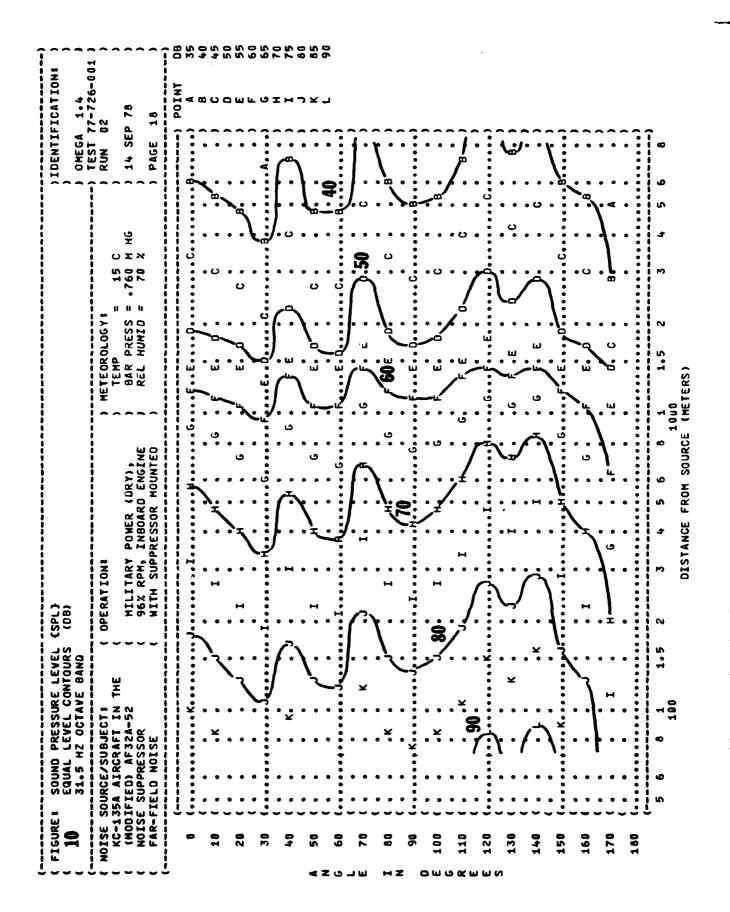
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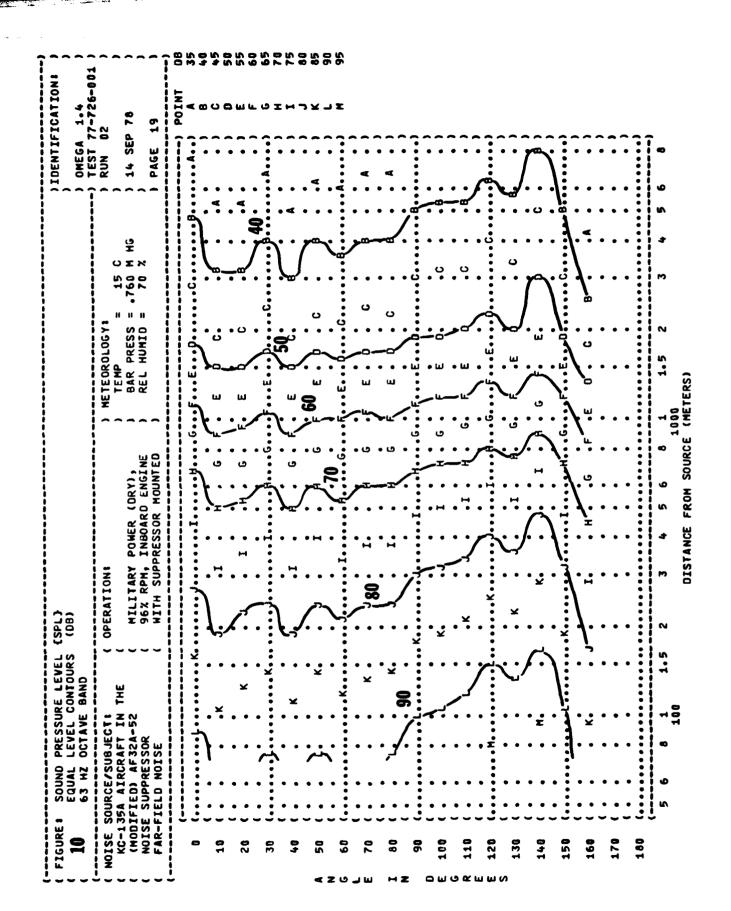
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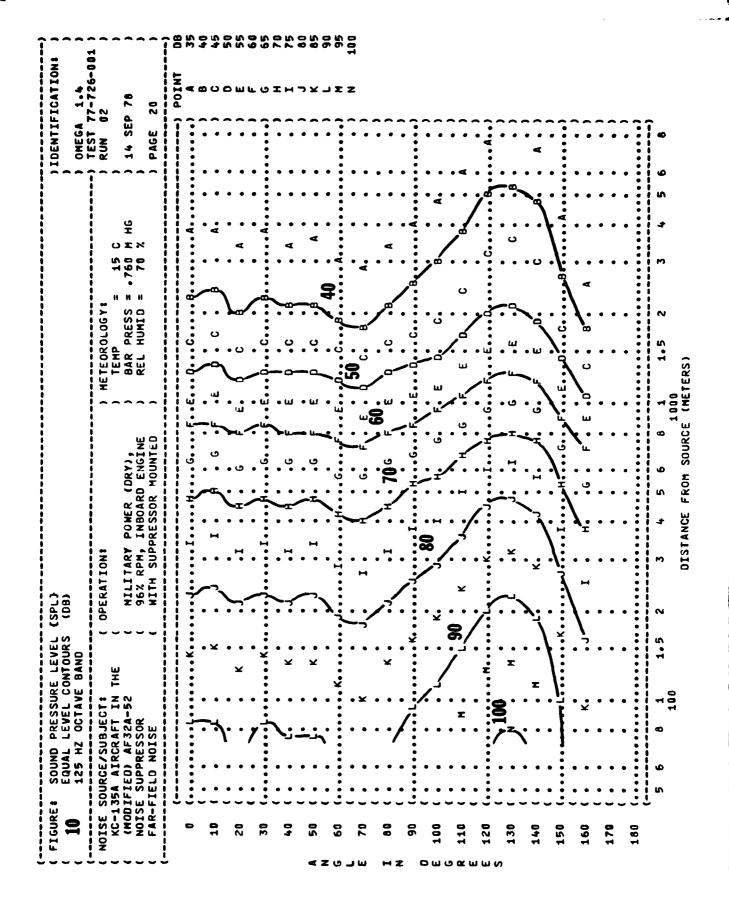
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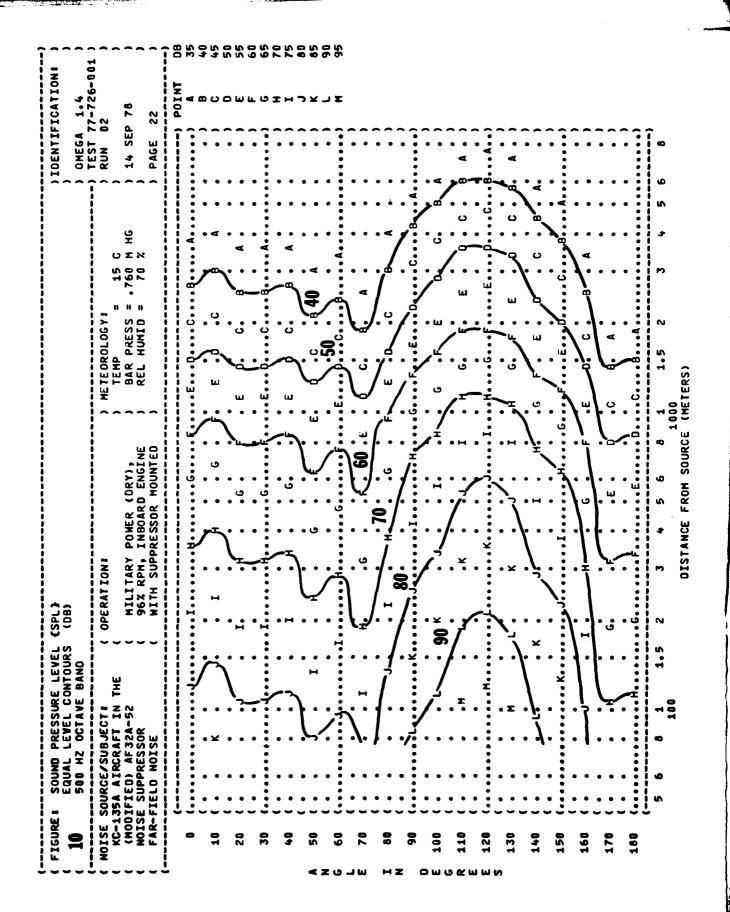
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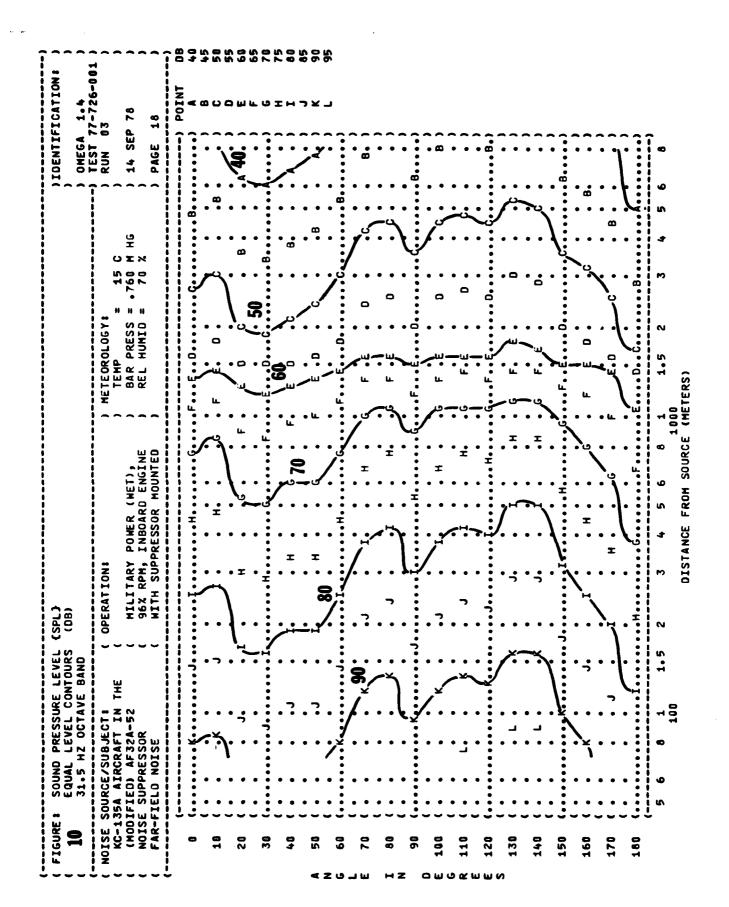
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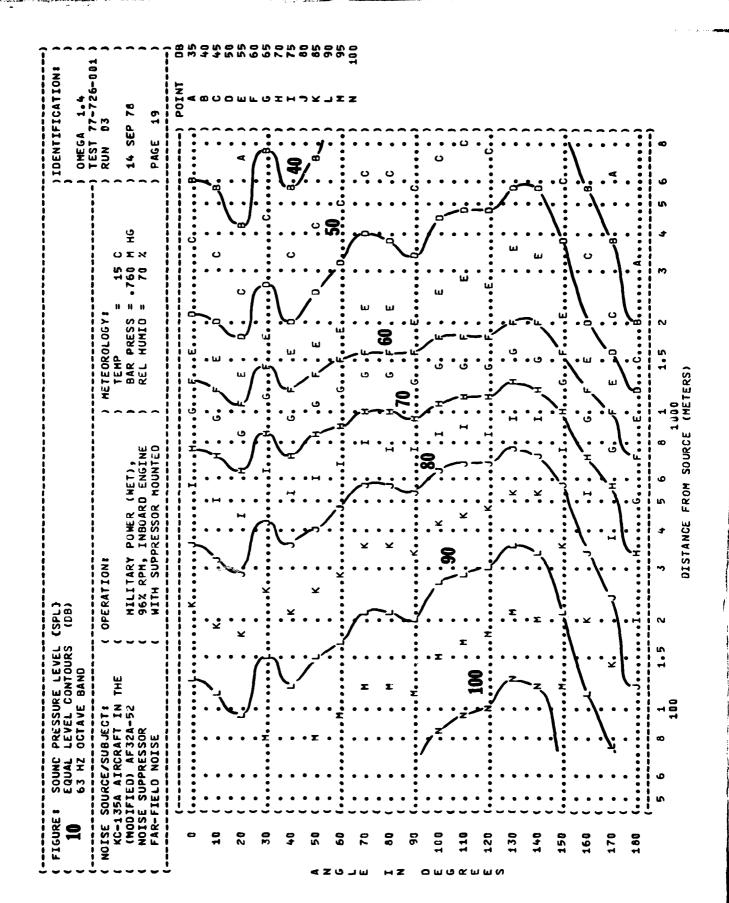
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